

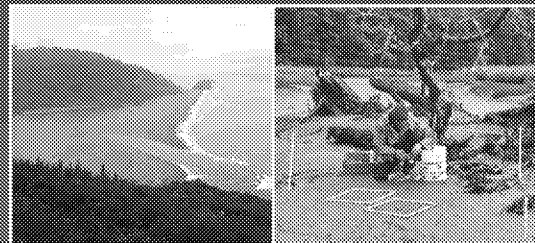


Nutrient Management for Sustainability of Coastal Ecosystems in the Pacific NW

A Locally Applicable Toolbox

Cheryl Brown, Pat Clinton, Jim Kaldy, TChris Mochon-Collura,
Walt Nelson, David Specht, David Young

Pacific Coastal Ecology Branch
Western Ecology Division

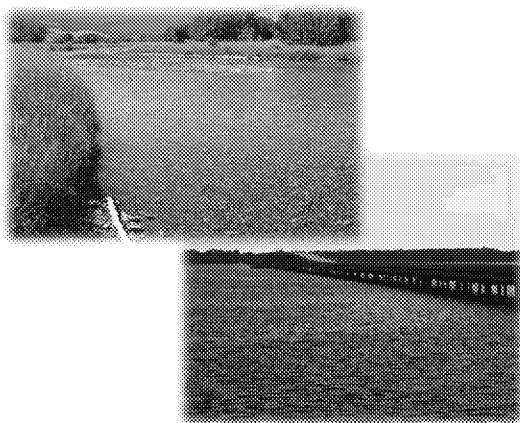


Office of Research and Development
National Health and Environmental Effects Research Laboratory



WED Research is a Component of a National Effort

ORD Safe and Sustainable Water Resources
**Nutrient Management for Sustainability
of Upland and Coastal Ecosystems**
A Locally Applicable Tool Box



James D. Hagy III
SSWR 2.3.A Task Lead

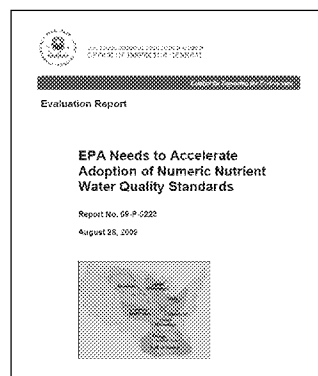
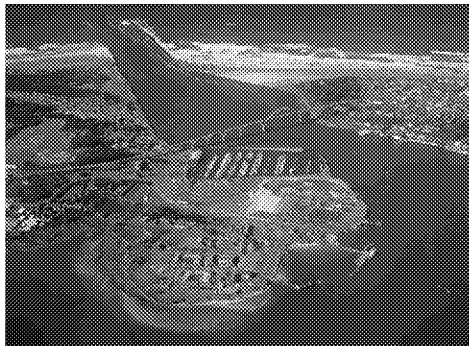
NHEERL Gulf Ecology Division
NHEERL Atlantic Ecology Division
NHEERL Western Ecology Division

Clients: HQ, Region 10, Oregon DEQ,
Tillamook NEP, Cal EPA

<http://nepis.epa.gov/Exe/ZyNET.exe/P1009AXH.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C06thru10%5CTxt%5C00000022%5CP1009AXH.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL>

Context for EPA/ORD support for Numeric Nutrient Criteria

- Improve the scientific tools available to support a coherent, effective and sustainable national response to the threat of nutrient enrichment ...
- Initially, by providing scientific support for regulatory water quality management through development of numeric nutrient criteria (NNC).



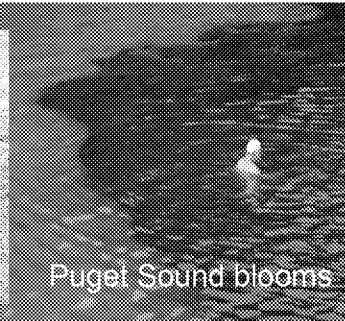
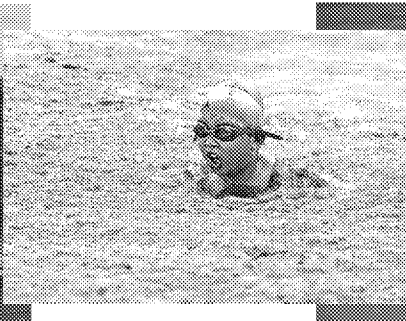
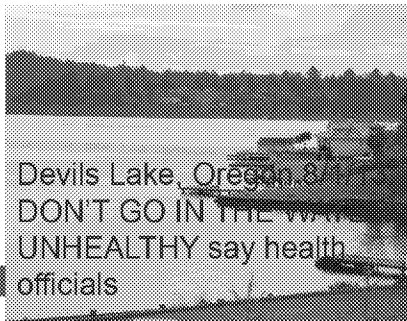
Excess nutrient loading continues to be the most prevalent cause of water quality impairment in U.S. Tools are needed to support a coherent, effective and sustainable response to the threat of nutrient enrichment... that are locally applicable.

EPA Needs to Accelerate Adoption of Numeric Nutrient Water Quality Standards. August 2009. Office of Inspector General Report 09-P-0223.



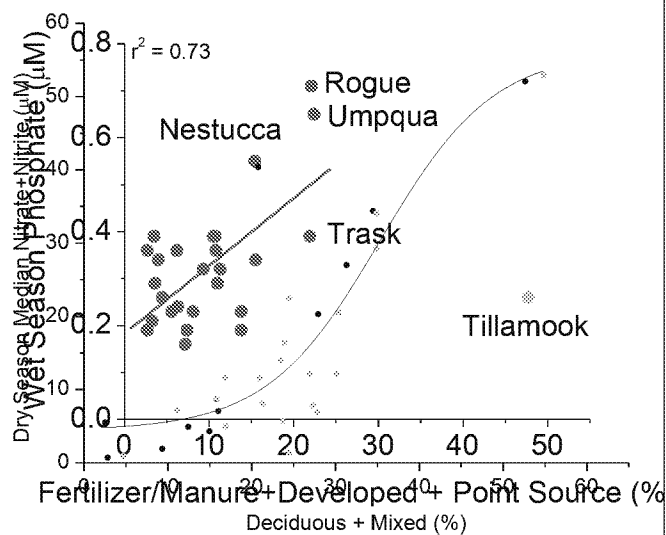
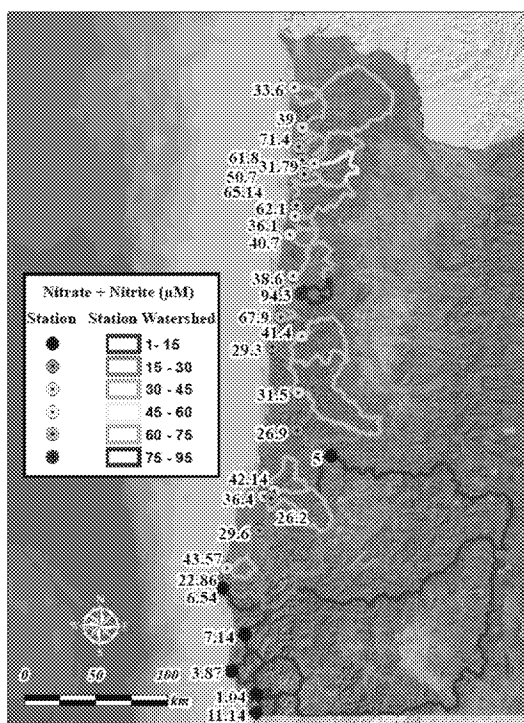
Oregon Estuaries: Why Develop Numeric Nutrient Criteria?

- Numeric nutrient criteria (NNC) are important tools to protect water quality and designated uses.
- Proactive versus reactive (TMDLs).
- Most Oregon estuaries are not currently exhibiting symptoms of nutrient impairments, and thus can be protected before degradation (Bricker et al., 2007).
- It's achievable. There are a limited number of larger estuaries.
- Climate change may increase vulnerability.



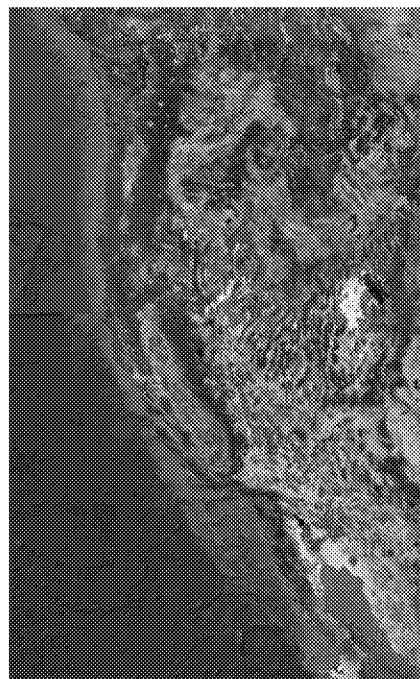
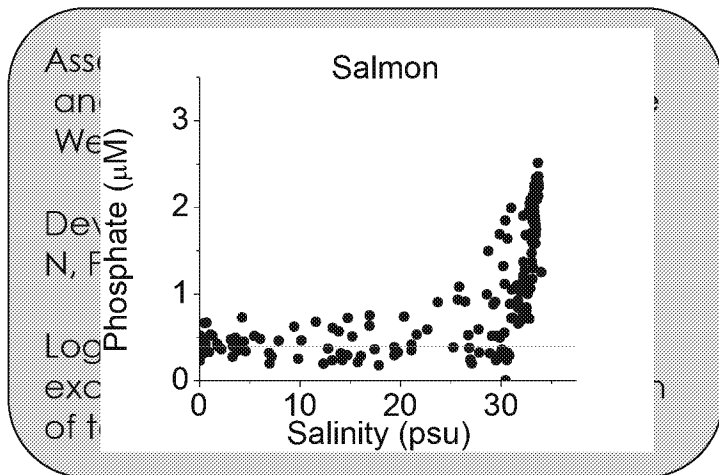
Bricker et al (2007) caveat; many OR estuaries didn't have sufficient data to assess eutrophication status.

Reference Condition for Nitrogen and Phosphorous



Engaged with State, Region 10, and HQ.

Marine Reference Conditions as an Approach to NNC



Tools to Aid Condition Assessment and Determine Compliance to Water Quality Standards

Coastal upwelling influences water quality in coastal ocean & estuaries.

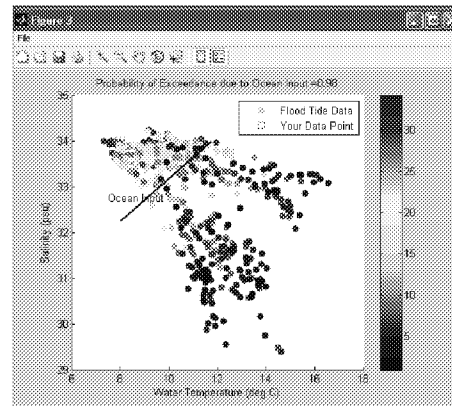
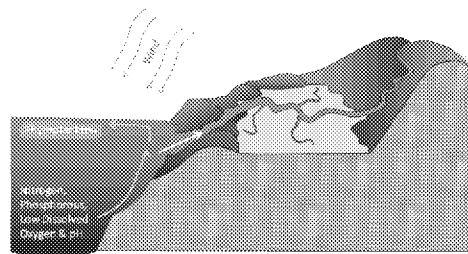
Peak values may exceed water quality criteria & eutrophication indicators

Distinct thermal & saline signatures.

Producing user-friendly tools.

Goal:

Reduce type I errors (falsely listing a segment as impaired).



By excluding observations associated with ocean input from water body assessments, type I errors in listings (i.e., falsely listing a segment as impaired when it isn't) may be reduced.

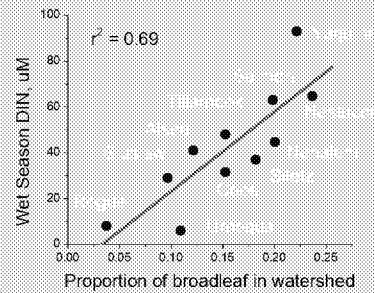
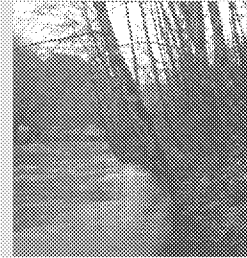
Tools to Distinguish Natural from Anthropogenic Nutrient Non-point Sources

Oregon estuaries receive nutrients from both natural & anthropogenic sources.

Tools are needed to distinguish among sources, such as upwelling, red alder, and point source inputs.



Isotope ratio
of macroalgae
& mixing models



Native species

Colonizes disturbed areas.

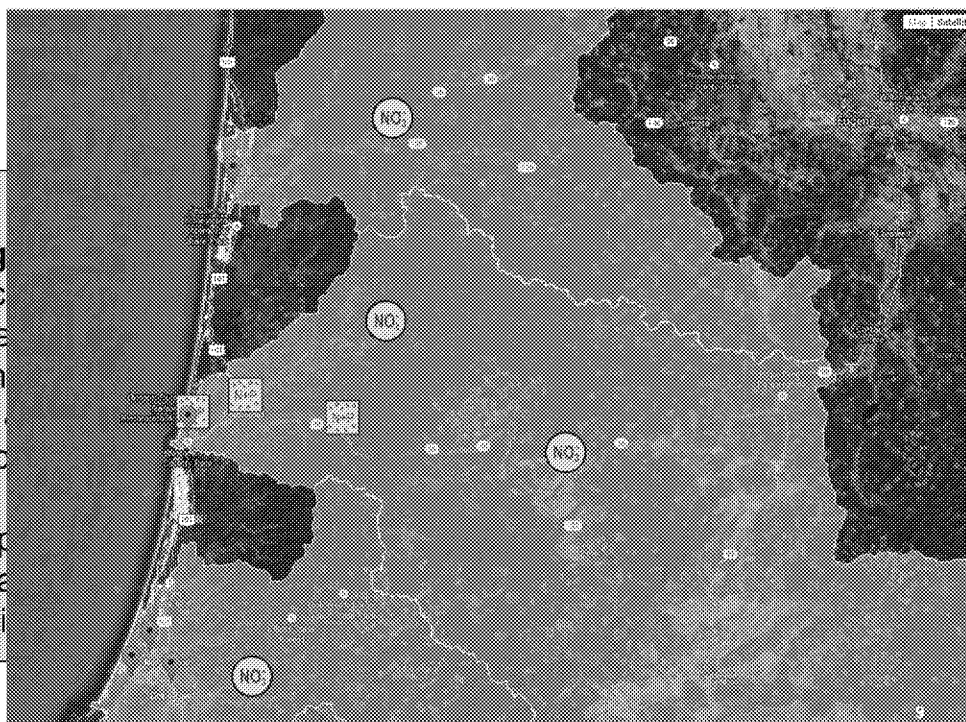
Symbiotic N₂ fixing bacteria

Nitrate in streams related to alder cover (Compton et al. 2003)

Extend 15N to periphyton.

Web-Based Tools for Estuarine Nutrient Criteria

Synthesizing
Watershed c
Point Source
Stream N an
Sediment C
Macroalgal b
Seagrass
Stable Isotop
Chlorophyll a
Nutrient Limi

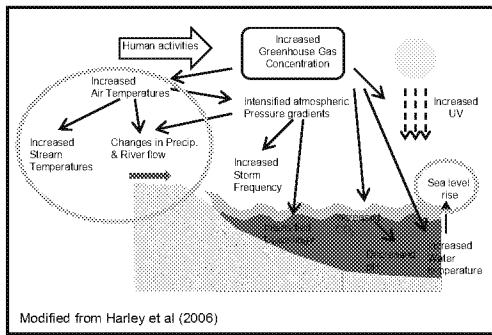


Impact of Climate Change on Attaining Water Quality Standards



Prepared in cooperation with the U.S. Environmental Protection Agency and the Oregon Climate Change Research Institute

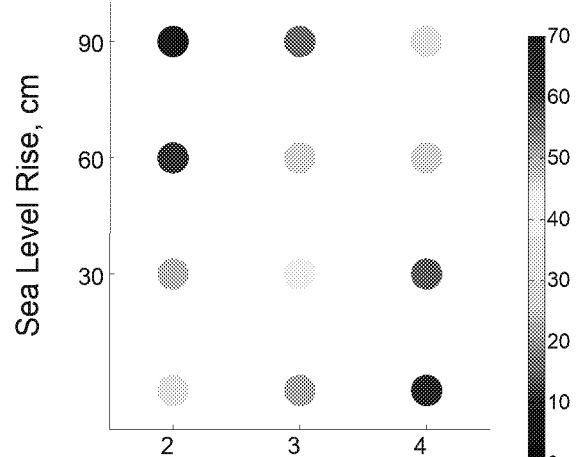
Potential Climate-Induced Runoff Changes and Associated Uncertainty in Four Pacific Northwest Estuaries



Open-File Report 2012-1274

U.S. Department of the Interior
U.S. Geological Survey

Increase in Number of Days Not Meeting Temperature Criterion 7 -day Avg. Max Temperature > 18 deg C



Air Temperature Increase, deg C
Number of Days Exceeding Criterion Under
Present Conditions = 38

Tools to Establish Relationship of Nutrient Loads to Biological Responses

Results from Temperature x Nutrient Experiments

- *Z. marina* did not exhibit nitrate toxicity.
- Temperature may not exacerbate *Z. marina* response to nitrogen loading.
- *Z. marina* stressed by warm temperatures may be susceptible to wasting disease.
- Pacific Northwest *Z. marina* may be more sensitive to climate change than nutrients.





Coastal & Ocean Acidification: *"The Other CO₂ Problem"*

Office of Research and Development
National Health and Environmental Effects Research Laboratory

We feel that this is an important emerging issue that cross cuts across all three RAPS. In addition, ORD has the expertise to make important contributions on this agency relevant Topic.

The Seattle Times

Shellfish at risk: Puget Sound becoming acidified

The waters of Puget Sound and Hood Canal are becoming more acidified as a result of rising carbon dioxide from industry, power plants and vehicles. Scientists from the University of Washington and the National Oceanic and Atmospheric Administration warn that the shifting water chemistry could damage the region's shellfish industry.

The Seattle Times

Oysters in deep trouble: Is Pacific Ocean's chemistry killing sea life?

Oyster larvae have been dying by the billions. Scientists suspect it's a sign that carbon dioxide is dramatically affecting the ocean — and if they're right, it could push Washington into the center of the debate about the future of the seas.

Are Oysters Doomed?

Don't believe in climate change? Talk to a clam digger.

By Monica Delany • Puget Sound, Nov. 10, 2012, at 1:05 PM



MONICA DELANY FOR THE SEATTLE TIMES. PHOTO BY JEFFREY M. HARRIS FOR THE SEATTLE TIMES.

The New York Times

March 12, 2010

Some See Clean Water Act Settlement Opening New Path to GHG Curbs

PBS NEWSHOUR

Topics Video Recent Programs Teacher Resources The Rundown

REPORT AIR DATE: Dec. 7, 2012

Trouble in the Water: Acidifying Oceans Hinder Health of Northwest Shellfish

ARTS & CULTURE
JAZZ
CLASSICAL
FILM
TELEVISION
MUSIC
THEATRE
DANCE
LITERATURE
SCIENCE
HISTORY
POLITICS
ECONOMY
ENVIRONMENT
HEALTH
LIFE
NATURE
SOCIETY
TECHNOLOGY
SPORTS
TRAVEL
FOOD
FASHION
ENTERTAINMENT
CULTURE
LIFESTYLE
OPINION
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TECHNOLOGY
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BOOKS

Los Angeles Times

Oceans' rising acidity a threat to shellfish — and humans

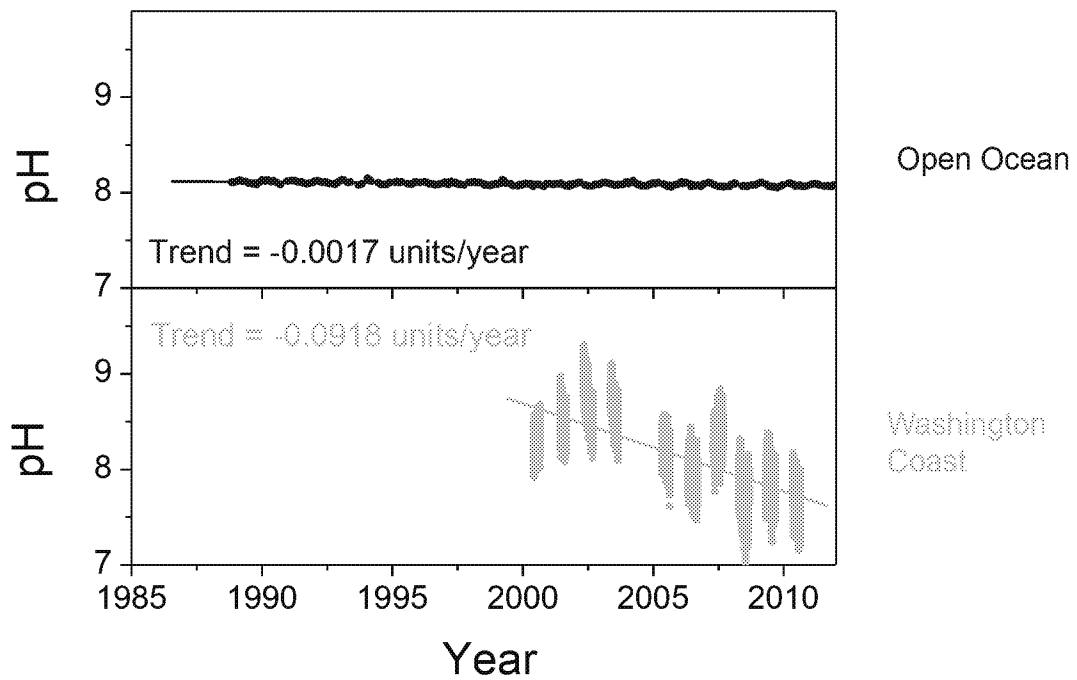
By Kenneth R. Weiss, October 6 2012

As carbon dioxide continues to build up in the atmosphere as a result of burning fossil fuels, the seas absorb much of it. The full effects have yet to be felt.



Lots of press, resonating with the public

Coastal & Ocean Acidification



This slide is animated (click through it).

The top slide shows open ocean time series from Hawaii.

Then Wootton data appears; then next click is the top panel is re-scaled.

The point, coast acidification is occurring at a much more rapid rate than in the open ocean.

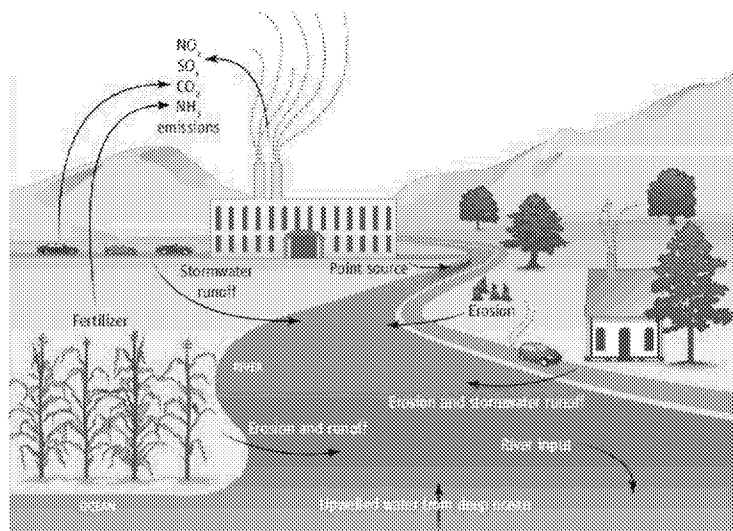
The next slide shows some of the potential drivers.

OCEANS

Mitigating Local Causes of Ocean Acidification with Existing Laws

R. P. Kelly,^{1,*} M. M. Foley,^{1*} W. S. Fisher,² R. A. Feely,³ B. S. Halpern,⁴ G. G. Waldbusser,⁵
M. R. Caldwell¹

Even as global and national efforts struggle to mitigate CO₂ emissions, local and state governments have policy tools to address "hot spots" of ocean acidification.



Contributors to ocean acidification. In addition to global atmospheric CO₂, this figure depicts the major local (within 100 km) sources contributing to coastal ocean acidification.

“Local & state governments have both the authority and motive to address many stressors that drive or exacerbate acidification conditions”



Clean Water Act

Litigation Relevant to Coastal Acidification

May 2009: Center for Biological Diversity (CBD) sued EPA for failure to list WA coastal waters as impaired due to ocean acidification.

Based on marine pH water quality standard.

March 2010: CBD lawsuit settled.

Nov 2010: EPA acknowledged the seriousness of aquatic life impacts associated with OA. The memo also described how the states may incorporate OA in the 303(d) program and acknowledged that information for listing for OA impairments is absent or limited.

States Petitioned by CBD to list coastal waters as impaired due to OA

2007: Alaska, California, Hawaii, Oregon, Washington
New York, New Jersey, Florida, Maine, Delaware

2009: Massachusetts, New Hampshire

2010: Texas

2011: Connecticut, Georgia, Rhode Island

Memo to WDD and Regions

16 states have been petitioned.

http://www.biologicaldiversity.org/campaigns/endangered_oceans/action_timeline.html

EPA will provide states with additional 303(d) guidance.

Litigation Relevant to Ocean Acidification

2007: CBD petitioned EPA to revise national 304(a) pH criteria arguing that is was not sufficient to protect aquatic life from OA impacts.

April 2010: EPA denied the petition due to insufficient data to appropriately address the natural variability in pH across coastal regions

2012: CBD requested that EPA promulgate the 304(a) recommended pH criteria to 15 coastal states that they felt had less stringent criteria to protect aquatic life.

WA Dept of Ecology requested that EPA assess WQC relevant to OA.

2013: EPA convening a technical workgroup to review data and research relevant to understanding OA and it's causes.

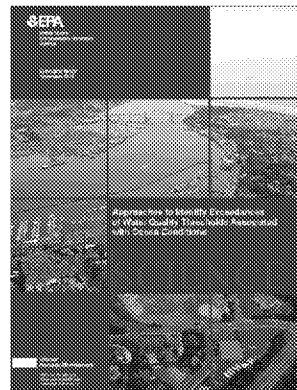
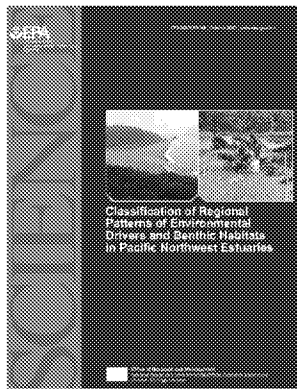
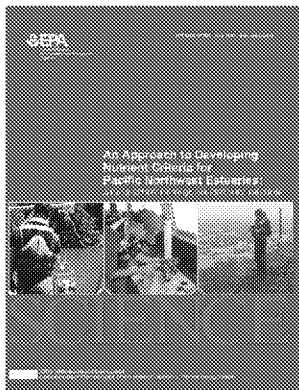
2013: CBD requested additional WQS, including aragonite saturation state numeric criteria and shellfish calcification rate narrative criteria, under CWA Section 304 to better protect aquatic life from OA and provide guidance to States.

July 2013: CBD filed notice of intent to sue EPA for failure to list OR and WA coastal waters as impaired due to OA.

"PH range of 6.5 to 8.5 for marine aquatic life (but not varying more than 0.2 units outside of the normally occurring range) . This criterion applies to open-ocean waters within 3 miles of a State or Territory's shoreline where the depth is substantially greater than the euphotic zone

Products

- 2.3.A.10 Simulation modeling tools to examine the effect of climate change and other drivers on estuarine water quality (2014)
- 2.3.A.11 Tools to assess compliance with numeric nutrient criteria and distinguish among nutrient sources affecting estuarine ecosystems in the Pacific Northwest (Milestone 2014)
- 2.3.A.12 Load-response relationships for nutrients to multiple estuarine response endpoints (e.g. seagrass, macroalgae and other candidate indicators) (Milestone 2015)
- 2.3.A.7 Incorporation of models for relationships between nutrients & biological responses into decision support tools to evaluate the impact of management scenarios on estuarine water quality & associated ecosystem services. (Milestone 2015)



EPA Nutrients Research Products & Contributions to State and National Efforts

